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Montana. State
Water Projects
Bureau
North Fork of
the Smith River
Dam

NORTH FORK OF THE SMITH RIVER DAM

Manual for Operation and Maintenance

State Water Projects Bureau
Water Resources Division
Department of Natural Resources and Conservation
1520 East Sixth Avenue
P. O. Box 202301
Helena, MT 59620-2301

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OVERVIEW

The North Fork of the Smith River Dam is located in Meagher County approximately 9 miles northeast of the town of White Sulphur Springs (Figure 1). The impoundment is commonly referred to as Lake Sutherlin. The project contains the water of the North Fork Smith River and its tributaries. Runoff is also supplied by 71-square-miles of drainage area (Figure 2). Storage capacity at the spillway crest, elevation 5,488.3 feet, is 11,500 acre-feet. At the first overtopping of the dam crest elevation 5,495.9 feet, 14,200 acre-feet of water is retained. The Montana DNRC owns the project and the Smith River Water Users Association is the project operator.

The earthfill dam was completed in 1936. The dam has a hydraulic height of 84 feet and a structural height of 91 feet. The crest width is 27 to 30 feet and the length is 1,300 feet. The dam's outlet works consist of 408 feet of reinforced concrete conduit which is horseshoe shaped 5 feet high and 5 feet wide. A manually-operated slidegate valve acts as the emergency gate control. The operating gate control is a manually-operated butterfly valve. The maximum capacity of the outlet is 860 cubic feet per second (cfs).

The spillway, a concrete structure with flashboards, has a crest width of 80 feet. The chute width at the downstream end of the concrete section is 40 feet. The flashboards are 3 inches thick and 28 inches high. To the first overtopping of the dam crest elevation 5,495.9 feet, the spillway capacity is 5,530 cfs.

Although water from the reservoir is primarily used for irrigation purposes, other uses include recreation, flood water detention, and sediment accumulation.

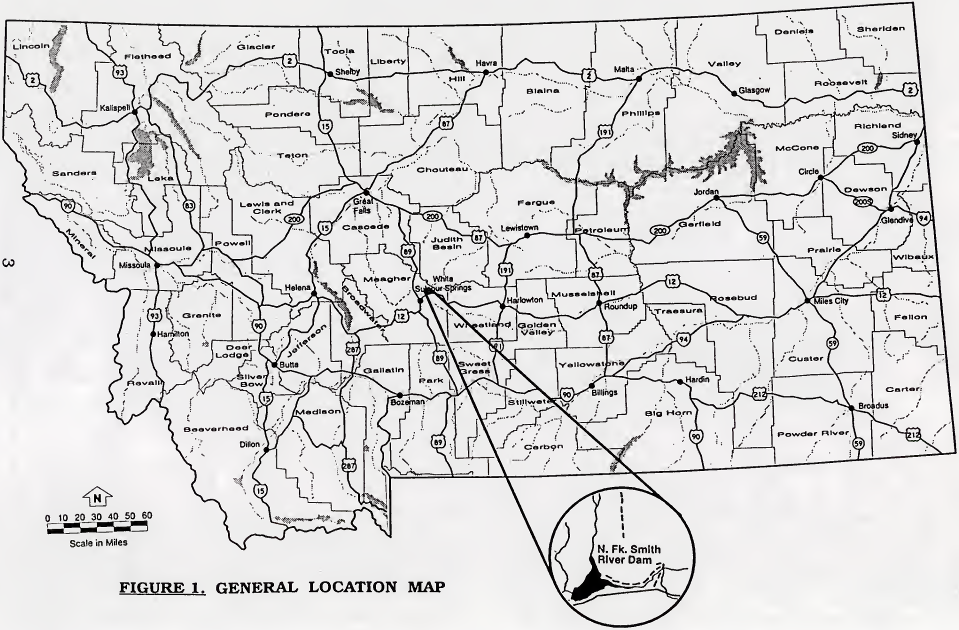

FIGURE 1. GENERAL LOCATION MAP

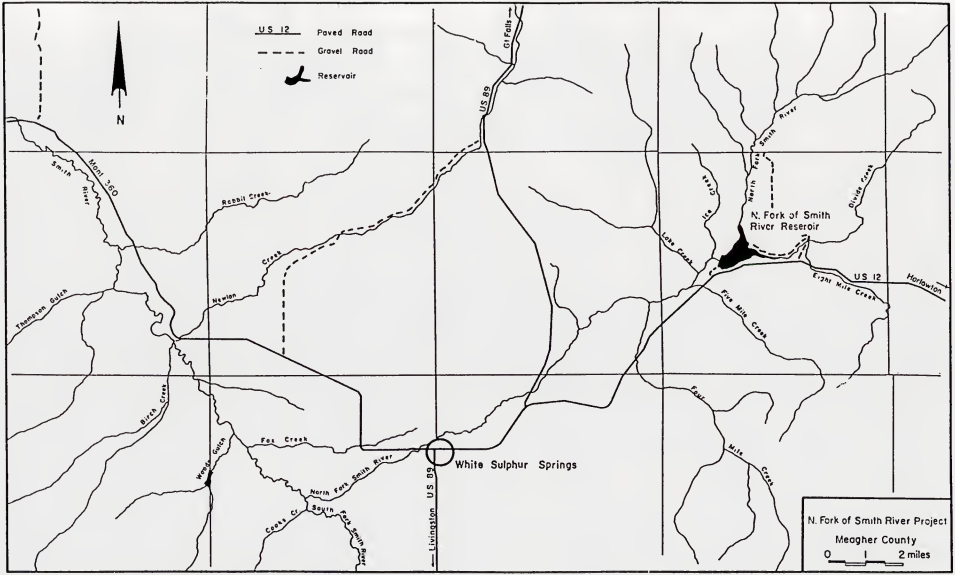

FIGURE 2. PROJECT AREA MAP

STATISTICAL INFORMATION

1. General

a) Owner	Montana Department of Natural Resources and Conservation (DNRC)
b) Operator	Smith River Water Users Association
c) Location	Sections 17 and 20, Township 10 North, Range 8 East, 9 miles northeast of White Sulphur Springs, Montana
d) Latitude Longitude	46° 37' 24" 110° 44' 48"
e) County--State	Meagher--Montana
f) Watershed Location	The North Fork Smith River. Main watershed lies primarily northeast of the dam.
g) Drainage Area	71 square miles

2. Principal Elevations (feet above mean sea level)

a) Maximum Dam Crest	5495.9 feet
b) Normal Full Pool	5488.3 feet (with flashboards)

3. Reservoir

a) Length of Maximum Pool (approximate)	2.2 miles
b) Maximum Reservoir Level of Record	5,489.44 feet (6-1-82)

c)	Surface Area at Normal Pool	335 acres

4. Storage

a)	Maximum Storage (elevation 5,495.9 feet)	14,200 acre-feet
b)	Active Storage	11,500 acre-feet
c)	Maximum Surcharge (elevation 5,495.9 feet)	2,700 acre-feet

5. Hydrology

a)	Inflow Design Flood (31,159 cfs peak flow)	Probable Maximum Flood (PMF)
b)	500-year Flood	2,080 cfs
c)	100-year Flood	1,375 cfs

6. Embankment

a)	Type	Earthfill
b)	Hydraulic Height	84 feet
c.)	Crest Length	1,300 feet
d)	Crest Width	27 to 30 feet
e)	Upstream Slope	1v on 2h (top), 1v on 3h (bottom)
f)	Downstream Slope	1v on 2h

7. Spillway

a)	Location	Right abutment
b)	Type	Uncontrolled concrete ogee crest with 28-inch high wooden flashboards
c)	Crest Width	80 feet
d)	Crest Elevation	5,488.3 feet (flashboards) 5,486.0 feet (concrete crest)
e)	Chute Width	80 feet tapering to 40 feet
f)	Capacity	5,530 cfs at elevation 5,495.9 feet

8. Outlet Works

a)	Size	5 feet high and 5 feet wide reinforced concrete, modified horseshoe shaped conduit.
b)	Length	408 feet
c)	Control	Emergency gate: manually operated 54-inch diameter slide gate Operating gate: manually operated 54-inch diameter butterfly valve.
d)	Capacity at elevation (5,488.3 feet)	820 cfs
	Capacity at Minimum Dam Crest elevation (5,495.9 feet)	860 cfs
e)	Design Invert Elevation	5,413.5 feet
f)	Trashrack	Assumed trashrack in place

OPERATING PROCEDURES

North Fork of the Smith River Dam is operated by the Smith River Water User's Association (herein called "association"). The primary goal of operating the reservoir is to provide an adequate supply of irrigation water to meet contracts with water users without exceeding safe storage or flow levels.

Method and Schedule of Operation

A court decree dictates that the natural flow of the river be allowed to pass through the dam whenever decreed water right holders demand their water, primarily during the heat of the irrigation season. Consequently, most of the water stored in the dam is collected during spring thaw or when there is flow in the river in excess of water needed by the decreed water users. Usually stored water isn't needed for early irrigation. Water is not typically released from storage until June 1st or later and the gates can usually be shut before October 1st. However in dry years releases may begin as early as May 15, and stored water may be depleted before October 1st. Having the reservoir full before users begin calling for their first water in the spring is the project's major goal. Naturally, these dates vary depending on each year's actual climatological and hydrological conditions.

Most water users divert directly out of the river. The South Side Canal, a state-financed delivery system, is the only organized multiple diversion project using water from Lake Sutherlin. This canal, which is operated by the South Side Water Users Association, is 12.5 miles long and has a capacity of 60 cfs. Two 30-inch diameter slide gates control flows into the canal and a water stage recorder is used to measure diversions.

With a water right decree in effect, a District-Court-appointed Water Commissioner is actually in control of releases from the dam. This Commissioner is not the same person who actually operates the dam. The Commissioner uses one weir, upstream of the dam and another weir immediately downstream of the outlet structure to monitor inflows and outflows from the dam. In order for the Commissioner to function effectively, all diversions from the North Fork of the Smith River must have water measuring devices in good, working condition. The Commissioner's authority ends where the North Fork and the South Fork of the Smith River join in Section 21, Township 9 North, Range 6 East, Meagher County. This is because the South Fork Smith River is not an adjudicated stream.

Safe Drawdown

The stability of the dam has been investigated. As a result of this investigation the recommended drawdown rate is 1 foot per day.

Limitations of Appurtenances

Appurtenances at the North Fork of the Smith River Dam consist of the outlet works and the spillway. The capacity of the outlet works is 860 cfs at the minimum dam crest. In addition, the spillway will discharge 5,530 cfs with the reservoir's water elevation at the dam crest. The spillway rating table is shown in **Appendix A**.

Dam Operator

Except for those daily releases controlled by the Water Commissioner from approximately May 1 to October 1, the responsibility for the operation of the dam and reservoir rests with the association and its dam operator. The dam operator is generally authorized to operate the reservoir to meet the association's goal. The dam operator's specific responsibilities are to:

1. *Coordinate filling of the reservoir and the release of water.* This requires operation of the mechanical features of the outlet works.
2. *Notify the State Water Projects Bureau (SWPB) of unusual occurrences* such as impending floods, excessive seepage, etc.
3. *Perform various maintenance tasks.*
4. *Maintain water level records and report the findings to the SWPB.* Normally water level measurements are taken monthly during the irrigation season.
5. *Monitor weather conditions.*
6. *Monitor seepage.*

A new dam operator would typically be trained by the out-going dam operator and the water users association. Training focuses on the mechanical operation of the gates, storage level measurement, the rate of water release measurement, and record keeping. The outlet gates are hand-operated. The outlet works are used to control the release of irrigation water and to regulate reservoir water levels during the normal filling process. The gates are also used to draw down the water level in the fall if the SWPB determines that the level is too high for safe winter and runoff season operation. Generally the outlet gates are not designed to provide emergency relief. Outlet releases during the non-irrigation season are usually dictated by river flows and freeze/thaw conditions.

The Water Commissioner is typically available daily during the irrigation season to observe the dam and perform operating functions. The dam operator usually checks the dam one or two times a day during heavy runoff periods. During the rest of the year, no schedule is established for observation of the structure.

Communications between the dam operator, the association, and the SWPB typically take place by telephone. At the present time, no radio communications are available.

Weather Monitoring

Weather conditions will be monitored by the dam operator through normal, local weather forecasts and the National Weather Service.

Interaction with Other Dams

The only dams located between the North Fork of the Smith River Dam and the mouth of the Smith River some 116.5 miles downstream are local irrigation diversion dams. The safety of these dams is not affected by the operation of the North Fork of the Smith River Dam during either normal or emergency operations. Therefore, interaction with other dams is not a concern of the normal operation of the North

Fork of the Smith River Dam. Once the flood wave from either a clear weather or a probable maximum flood breach reaches the mouth of the Smith River, there are a number of Montana Power Company power-generation dams downstream that would be impacted. Since even with the clear weather breach scenario, there would be in excess of 8,500 cfs additional flow dumped into the Missouri River, if it appears that the North Fork of the Smith River Dam will breach, the dam operator should notify the Montana Power Company 24-hour Dispatch Service for Rainbow Dam in Great Falls at **406-453-5712** or **406-761-1101**. If there is no answer, the Systems Operation Control Dispatch Center in Butte should be notified at **406-494-4131** or **406-494-4133**.

INSPECTION AND MONITORING

The SWPB conducts annual inspections of the dam. Appendix B includes an example of a bureau inspection checklist. In addition to annual inspections, SWPB personnel will inspect the dam and reservoir during and after heavy runoff, during and after severe rainstorms and windstorms, during high storage periods, and after an earthquake. The embankment is not monitored by instrumentation.

Structural Features Inspection

Structural features include the gate house, outlet works, and the spillway. The SWPB inspects these structures annually as part of its inspection program. Items to be checked or noted include, but are not limited to, the following:

1. *Outlet Works*
    - a) Any differential settlement or movement resulting in cracking of the conduit
    - b) Erosion of the seals or concrete by cavitation immediately downstream of the gates
    - c) Major seepage of water into the conduit
    - d) Major deterioration of exposed concrete due to freeze/thaw cycles or sulfate reactions
    - e) Operation of both gates through a full cycle
    - f) Unobstructed operation of the air vent
    - g) Corrosion of any metal
    - h) Proper lubrication of the gate pedestals

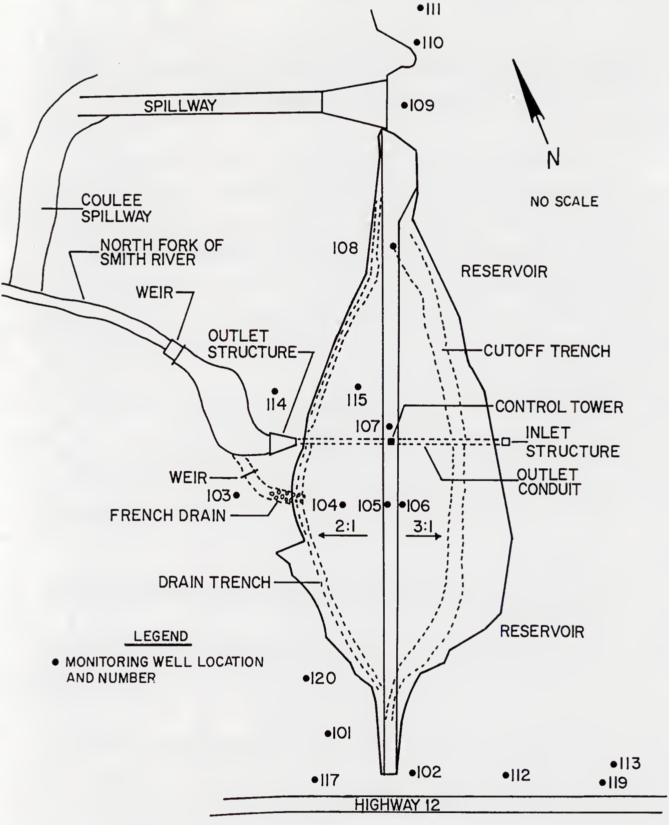

FIGURE 3.

GENERAL LAYOUT

2. *Gatehouse* — any damage or vandalism

3. *Spillway*
    a) Deterioration of concrete
    b) Separation or movement of joints
    c) Erosion of the spillway chute, backfill behind the walls, or stilling basin
    d) Blockage of the approach or exit channel

4. *Embankments*
    a) Erosion gullies in dam and dike faces.
    b) Damage from burrowing animals or vegetation.
    c) Displacement or loss of rip-rap protection.
    d) Displacement of fill, sink holes, slumps etc.
    e) Any seepage.

Riprap Inspection

The riprap along the face of the dam should measure at least 30 inches thick. Immediately after the occurrence of high water, the riprap should be inspected and additional riprap added if needed.

Seepage Monitoring

Minor seepage at the toe of the embankment is marked by a swampy willow-infested area. A french drain above the outlet discharges a constant flow into the swampy area. A "V-notch" weir measures seepage from the swampy area. Personnel from the Lewistown Regional Office of the DNRC read this weir and take water level measurements on a series of peizometers across the dam on a monthly basis. These records are sent to the SWPB. All seepage sources are observed and monitored by the dam operator during regular visits and by the SWPB during annual inspections. To date, seepage flows have remained relatively steady.

Monitoring Program

There are 20 observation wells located on or around the dam. These observation wells are measured bimonthly during the irrigation season and monthly during the remainder of the year by the Lewistown regional office staff. The measurements are forwarded to the Water Resources Division in Helena for analysis of the data. A description of the monitoring wells is shown on the following page.

TABLE 1

MONITORING WELLS

Well No.	Depth *(feet)*	Well Location
101	20.1	Left abutment
102	113.5	Left abutment
103	60.0	Toe of the dam
104-A	61.0	Downstream face of the dam
104-B	95.3	Downstream face of the dam
105-A	120.3	Crest of the dam
105-B	70.0	Crest of the dam
106	60.0	Dam crest - upstream face
107-A	57.3	Crest of the dam
107-B	103.0	Crest of the dam
108	113.4	Right abutment
109	40.0	Spillway approach channel
110	53.7	Right abutment
111	30.5	Right abutment
112	27.0	North side of Highway 12
113	25.0	North side of Highway 12
114	60.0	Right downstream toe of the dam
115	47.0	Downstream face of the dam
118	29.0	South side of Highway 12
120	35.4	Left abutment contact

Note: The numbers are not consistent because not all of the drill holes drilled during the 1989 geotechnical investigation had monitoring wells installed in the drill holes.

MAINTENANCE

The association is responsible for the project's routine maintenance. Normal maintenance activities will be identified and performed by the dam operator during regular visits. Other items needing maintenance or repair will be identified during the annual inspections conducted by the SWPB. Major repairs may be supervised by the SWPB.

Routine Maintenance

Any routine maintenance necessary to protect the dam or keep it in good working order will be performed by the dam operator as soon as a need is identified. The dam operator will watch for any potential maintenance requirements during normal visits to the dam. Items that may need occasional attention include, but are not limited to:

1. *Lubrication of gate-operating mechanisms.*
2. *Debris or silt restricting the spillway inlet or the outlet works.* Accumulated debris that could affect the operation of these appurtenances will be removed at once, with all debris removed at least annually.
3. *Erosion gullies on embankment.* Development of erosion gullies should be checked immediately. Gullies should be filled, compacted, and seeded. Particular attention should be paid to the abutment contact areas and the downstream faces where four-wheel-drive tracks may become a problem.
4. *Rodent damage.* Rodent burrows should be filled immediately and the rodents destroyed.
5. *Upstream slope riprap.* Reservoir riprap normally will be maintained annually, but may need occasional repairs due to high water or wave action.

6. *Vegetative cover on downstream slopes.* Good vegetative cover must be maintained, but large brush should be removed.

Annual Maintenance

The SWPB conducts annual inspections of the North Fork of the Smith River Dam. During these inspections, any items that require maintenance are identified and recorded, and an inspection report is sent to the association.

Items identified during the inspection that may need annual maintenance include outlet works, gates, riprap, roads, and the gatehouse. Any other routine items that need immediate attention also will be noted during the annual inspection. The need to remove trees or brush also will be addressed in the report.

After the association receives the SWPB inspection report, it will develop a maintenance schedule for identified tasks. While the dam operator or association members may perform the routine tasks, major repairs more likely to be performed by a contractor. The SWPB may assist in contracting for repairs and may supervise the repair work.

Record Keeping

The SWPB maintains records — including photographs — of all inspections and maintenance requirements. These records also include flow measurements and storage volume. Anyone who wants to review these records may do so in the SWPB's office at the Department of Natural Resources and Conservation in Helena.

The dam operator will keep records of the reservoir elevation, seepage observations or measurements, and any unusual conditions. These records may be reviewed at the dam operator's house.

REFERENCES

Dubois, Craig, Water Resources Division Regional Office, Water Resources Specialist III. December 1994 telephone communications with Marvin Cross, Water Resources Division Regional Office, Civil Engineering Specialist, DNRC, Havre.

HKM Associates. April 1981. *Phase 1 Inspection Report, National Dam Safety Program, North Fork Smith River Dam, White Sulphur Springs, Montana, Meagher County, MT 9.* Prepared for the State of Montana (DNRC) under the U.S. Army Corps of Engineers National Dam Safety Program.

Zehntner, Howard, Smith River Water Users Association dam operator. December 1994 telephone communications with Marvin Cross, Water Resources Division Regional Office, Civil Engineering Specialist, DNRC, Havre.

APPENDIX A

RATING CURVES AND TABLES

TABLE A-1

NORTH FORK OF THE SMITH RIVER DAM
SPILLWAY RATING TABLE

Elevation *(feet)*	**Flow** *(cfs)*
5,488.3	0
5,490.0	590
5,492.0	1,880
5,494.0	3,590
5,495.9	5,530

This rating table is for use when the flashboards are in place.

FIGURE A-1

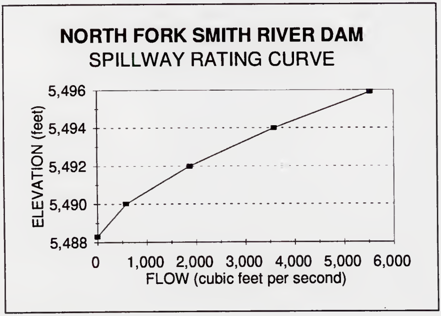

TABLE A-2

N.F. SMITH RIVER DAM
LIVE STORAGE TABLE

SLOPE DISTANCE	ELEVATION *(Feet)*	CONTENTS *(Acre-feet)*		SLOPE DISTANCE	ELEVATION *(Feet)*	CONTENTS *(Acre-feet)*
0+00	5493.86	13,450	Top of Pin #1	+58	84.03	10,099
0+20	89.83	11,878		+59	83.51	9,943
0+25	89.12	11,659		0+60	5483.43	9,920
+26	88.98	11,616		+61	83.25	9,866
+27	88.84	11,573		+62	83.04	9,803
+28	88.71	11,533		+63	82.82	9,737
+29	88.57	11,490		+64	82.56	9,659
0+30	5488.43	11,446		+65	82.37	9,602
+30.8	88.30	11,406	Top of Boards	+66	82.33	9,590
+31	88.21	11,379		+67	82.23	9,560
+32	88.09	11,342		+68	82.10	9,521
+33	87.93	11,292		+69	82.04	9,503
+34	87.81	11,255		0+70	5481.94	9,472
+35	87.66	11,209		+71	81.79	9,427
+36	87.50	11,160		+72	81.68	9,394
+37	87.31	11,101		+73	81.55	9,355
+38	87.17	11,058		+74	81.45	0,326
+39	87.05	11,021		+75	81.35	9,296
0+40	5486.78	10,938		+76	81.21	9,254
+41	86.59	10,880		+77	81.13	9,230
+42	86.21	10,763		+78	81.04	9,203
+43	86.01	10,701		+79	80.95	9,177
+43.1	86.00	10,698	Conc. Crest	0+80	5480.86	9,150
+44	85.94	10,680		+81	80.76	9,120
+45	85.81	10,639		+82	80.72	9,108
+46	85.75	10,621		+83	80.53	9,151
+47	85.63	10,584		+84	80.38	9,006
+48	85.52	10,550		+85	80.27	8,973
+49	85.37	10,504		+86	80.13	8,931
0+50	5485.24	10,464	Pin #2 Missing	+87	80.00	8,892
+51	85.18	10,445		+88	79.92	8,869
+52	84.96	10,378		+89	79.71	8,810
+53	84.89	10,357		0+90	5479.57	8,770
+54	84.66	10,288		+91	79.48	8,745
+55	84.51	10,243		+92	79.30	8,694
+56	84.36	10,198		+93	79.20	8,666
+57	84.22	10,156		+94	79.09	8,634

TABLE A-2 continued

SLOPE DISTANCE	ELEVATION (Feet)	CONTENTS (Acre-feet)		SLOPE DISTANCE	ELEVATION (Feet)	CONTENTS (Acre-feet)	
+95	79.06	8,626		+33	73.99	7,214	
+96	78.90	8,581		+34	73.73	7,147	
+97	78.80	8,552		+35	73.55	7,100	
+98	78.67	8,516		+36	73.51	7,090	
+99	78.54	8,479		+37	73.40	7,061	
1+00	5478.48	8,462	Top of Pin #3	+38	73.13	6,991	
1+00	5478.46	8,456		+39	73.03	6,965	
+01	78.30	8,411		1+40	5472.81	6,907	
+02	78.18	8,377		+41	72.68	6,873	
+03	78.04	8,337		+42	72.60	6,853	
+04	77.91	8,301		+43	72.51	6,829	
+05	77.78	8,264		+44	72.38	6,795	
+06	77.64	8,224		+45	72.30	6,774	
+07	77.48	8,179		+46	72.15	6,735	
+08	77.34	8,139		+47	72.04	6,706	
+09	77.21	8,102		+48	71.90	6,670	
1+10	5477.02	8,049		+49	71.77	6,636	
+11	76.97	8,035		1+50	5471.67	6,610	Pin #3 Missing
+12	76.87	8,006		+51	71.53	6,574	
+13	76.77	7,978		+52	71.42	6,545	
+14	76.61	7,933		+53	71.30	6,514	
+15	76.55	7,916		+54	71.15	6,475	
+16	76.42	7,879		+55	71.01	6,439	
+17	76.30	7,845		+56	70.86	6,400	
+18	76.18	7,811		+57	70.73	6,366	
+19	76.10	7,788		+58	70.58	6,327	
1+20	5475.97	7,752		+59	70.47	6,298	
+21	75.89	7,754		1+60	5470.32	6,259	
+22	75.68	7,669		+61	70.24	6,238	
+23	75.49	7,616		+62	70.06	6,192	
+24	75.36	7,579		+63	69.93	6,159	
+25	75.23	7,542		+64	69.78	6,124	
+26	75.11	7,508		+65	69.58	6,077	
+27	74.93	7,459		+66	69.39	6,032	
+28	74.69	7,396		+67	69.22	5,992	
+29	74.59	7,370		+68	69.14	5,973	
1+30	5474.43	7,329		+69	68.98	5,935	
+31	74.28	7,290		1+70	5468.88	5,912	
+32	74.12	7,248		+71	68.63	5,853	

TABLE A-2 continued

SLOPE DISTANCE	ELEVATION (Feet)	CONTENTS (Acre-feet)	SLOPE DISTANCE	ELEVATION (Feet)	CONTENTS (Acre-feet)
1+80	5467.44	5,573	+19	61.43	4,197
+81	67.30	5,540	2+20	5461.28	4,164
+82	67.16	5,507	+21	61.12	4,128
+83	67.03	5,476	+22	61.02	4,105
+84	66.92	5,450	+23	60.88	4,074
+85	66.80	5,422	+24	60.71	4,036
+86	66.73	5,406	+25	60.62	4,016
+87	66.61	5,377	+26	60.52	3,993
+88	66.47	5,345	+27	60.42	3,971
+89	66.34	5,314	+28	60.12	3,904
1+90	5466.26	5,295	+29	60.06	3,890
+91	66.21	5,283	2+30	5459.88	3,853
+92	66.09	5,255	+31	59.78	3,833
+93	65.92	5,215	+32	59.64	3,805
+94	65.78	5,182	+33	59.49	3,774
+95	65.47	5,109	+34	59.31	3,738
+96	65.32	5,074	+35	59.15	3,706
+97	65.24	5,055	+36	59.03	3,682
+98	65.12	5,026	+37	58.86	3,648
+99	65.04	5,007	+38	58.76	3,628
2+00	5465.18	5,040 {Top of Block #5	+39	58.61	3,598
+01	64.97	4,991	2+40	5458.43	3,561
+02	64.86	4,967	+41	58.30	3,535
+03	64.63	4,915	+42	58.14	3,503
+04	64.57	4,902	+43	58.05	3,485
+05	64.41	4,866	+44	57.91	3,457
+06	64.24	4,828	+45	57.78	3,431
+07	63.94	4,761	+46	57.66	3,407
+08	63.69	4,705	+47	57.54	3,383
+09	63.51	4,664	+48	57.44	3,363
2+10	5463.34	4,626	+49	57.34	3,343
+11	63.24	4,604	2+50	5457.22	3,319 {Pin #6 Missing
+12	63.12	4,577	+51	57.12	3,299
+13	62.93	4,534	+52	57.00	3,275
+14	62.77	4,498	+53	56.88	3,251
+15	62.21	4,372	+54	56.76	3,227
+16	61.96	4,316	+55	56.66	3,207
+17	61.81	4,282	+56	56.52	3,179
+18	61.55	4,224	+57	56.40	3,154

TABLE A-2 continued

SLOPE DISTANCE	ELEVATION (Feet)	CONTENTS (Acre-feet)	SLOPE DISTANCE	ELEVATION (Feet)	CONTENTS (Acre-feet)
+58	56.28	3,130	+97	51.08	2,214
+59	56.13	3,100	+98	51.00	2,201
2+60	5455.97	3,068	+99	50.95	2,193
+61	55.81	3,036	3+00	5450.97	2,196 {Top of Block #7
+62	55.66	3,006	+01	50.77	2,162
+63	55.55	2,984	+02	50.64	2,141
+64	55.46	2,965	+03	50.57	2,129
+65	55.37	2,947	+04	50.46	2,110
+66	55.28	2,929	+05	50.39	2,099
+67	55.18	2,909	+06	50.31	2,085
+68	55.09	2,891	+07	50.25	2,075
+69	54.95	2,865	+08	50.20	2,067
2+70	5454.83	2,844	+09	50.14	2,057
+71	54.66	2,816	3+10	5450.09	2,048
+72	54.55	2,797	+11	50.04	2,040
+73	54.39	2,771	+12	49.99	2,032
+74	54.13	2,727	+13	49.91	2,020
+75	53.96	2,698	+14	49.84	2,010
+76	53.82	2,675	+15	49.80	2,005
+77	53.73	2,660	+16	49.79	2,003
+78	53.40	2,604	+17	49.60	1,997
+79	53.26	2,581	+18	49.58	1,974
2+80	5453.13	2,559	+19	49.53	1,967
+81	53.06	2,547	3+20	5449.50	1,963
+82	52.84	2,510	+21	49.50	1,963
+83	52.71	2,488	+22	49.45	1,955
+84	52.63	2,475	+23	49.40	1,948
+85	52.53	2,458	+24	49.26	1,929
+86	52.48	2,450	+25	49.14	1,912
+87	52.35	2,428	+26	48.92	1,881
+88	52.23	2,408	+27	48.84	1,869
+89	52.07	2,381	+28	48.81	1,865
2+90	5451.94	2,359	+29	48.79	1,862
+91	51.89	2,351	3+30	5448.78	1,861
+92	51.80	2,335	+31	48.68	1,847
+93	51.62	2,305	+32	48.66	1,844
+94	51.51	2,287	+33	48.59	1,834
+95	51.39	2,267	+34	48.54	1,827
+96	51.24	2,241	+35	48.51	1,823

TABLE A-2 continued

SLOPE DISTANCE	ELEVATION (Feet)	CONTENTS (Acre-feet)	SLOPE DISTANCE	ELEVATION (Feet)	CONTENTS (Acre-feet)
+36	48.45	1,814	+77	46.94	1,602
+37	48.43	1,812	+78	46.89	1,594
+38	48.38	1,805	+79	46.83	1,586
+39	48.35	1,800	3+80	5446.78	1,579
3+40	5448.34	1,799	+81	46.73	1,572
+41	48.24	1,785	+82	46.64	1,559
+42	48.22	1,782	+83	46.59	1,552
+43	48.15	1,772	+84	46.59	1,552
+44	48.13	1,769	+85	46.55	1,547
+45	48.04	1,757	+86	46.50	1,540
+46	47.93	1,741	+87	46.46	1,534
+47	47.92	1,740	+88	46.39	1,524
+48	47.89	1,735	+89	46.31	1,513
+49	47.87	1,733	3+90	5446.31	1,513
3+50	5447.84	1,728 {Pin #8 Missing	+91	46.27	1,507
+52	47.74	1,714	+92	46.24	1,503
+53	47.71	1,710	+93	46.21	1,499
+54	47.69	1,707	+94	46.18	1,494
+55	47.65	1,702	+95	46.15	1,490
+56	47.64	1,700	+96	46.05	1,476
+57	47.62	1,697	+97	46.00	1,469
+58	47.62	1,697	+98	45.92	1,458
+59	47.55	1,688	+99	45.89	1,453
3+60	5447.43	1,671	4+00	5446.05	1,476
+61	47.41	1,668	+01	45.68	1,424
+62	47.40	1,666	+02	45.62	1,415 {Top of Block #9
+63	47.39	1,665	+03	45.45	1,391
+64	47.37	1,662	+04	45.44	1,390
+65	47.36	1,661	+05	45.37	1,380
+66	47.23	1,642	+06	45.33	1,375
+67	47.22	1,641	+07	45.20	1,356
+68	47.18	1,635	+08	45.08	1,339
+69	47.05	1,617	+09	45.06	1,336
3+70	5447.05	1,617	4+10	5445.01	1,329
+71	47.05	1,617	+11	44.99	1,327
+73	47.01	1,611	+12	44.95	1,323
+74	46.99	1,609	+13	44.81	1,309
+75	46.97	1,606	+14	44.78	1,306
+76	46.94	1,602	+15	44.73	1,301

TABLE A-2 continued

SLOPE DISTANCE	ELEVATION *(Feet)*	CONTENTS *(Acre-feet)*	SLOPE DISTANCE	ELEVATION *(Feet)*	CONTENTS *(Acre-feet)*
+16	44.66	1,294	+55	42.05	1,030
+17	44.62	1,290	+56	41.97	1,022
+18	44.62	1,290	+57	41.91	1,016
+19	44.54	1,282	+58	41.83	1,008
4+20	5444.46	1,273	+59	41.77	1,002
+21	44.42	1,269	4+60	5441.73	998
+22	44.36	1,263	+61	41.67	992
+23	44.26	1,253	+62	41.59	984
+24	44.19	1,246	+63	41.54	979
+25	44.15	1,242	+64	41.47	971
+26	44.08	1,238	+65	41.41	965
+27	44.03	1,230	+66	41.33	957
+28	43.96	1,223	+67	41.26	950
+29	43.91	1,218	+68	41.14	938
4+30	5443.87	1,214	+69	41.08	932
+31	43.82	1,209	4+70	5441.01	925
+32	43.75	1,202	+71	40.92	916
+33	43.69	1,196	+72	40.88	912
+34	43.62	1,189	+73	40.74	898
+35	43.57	1,184	+74	40.73	897
+36	43.49	1,175	+75	40.64	888
+37	43.43	1,169	+76	40.54	878
+38	43.37	1,163	+77	40.49	872
+39	43.29	1,155	+78	40.41	864
4+40	5443.24	1,150	+79	40.33	856
+41	43.16	1,142	4+80	5440.25	848
+42	43.10	1,136	+81	40.15	838
+43	43.01	1,127	+82	40.08	831
+44	42.92	1,118	+83	39.99	822
+45	42.85	1,111	+84	39.92	817
+46	42.79	1,105	+85	39.83	810
+47	42.71	1,097	+86	39.78	806
+48	42.63	1,089	+87	39.74	803
+49	42.57	1,083	+88	39.68	799
4+50	5442.46	1,071 Pin #10 Missing	+89	39.62	794
+51	42.38	1,063	4+90	5439.56	790
+52	42.29	1,054	+91	39.51	786
+53	42.21	1,046	+92	39.48	783
+54	42.12	1,037	+93	39.47	783

TABLE A-2 continued

SLOPE DISTANCE	ELEVATION *(Feet)*	CONTENTS *(Acre-feet)*	SLOPE DISTANCE	ELEVATION *(Feet)*	CONTENTS *(Acre-feet)*
+94	39.38	776	+32	37.46	630 {Big Rock
+95	39.29	769	+33	37.41	626
+96	39.21	763	+34	37.37	623
+97	39.18	761	+35	37.29	617
+98	39.12	756	+36	37.19	609
+99	39.08	753	+37	37.16	607
5+00	5440.12	835 {Top of Block #11	+38	36.95	591
5+00	39.01	748	+39	36.88	586
+01	39.00	747	5+40	5436.85	584
+02	38.97	745	+41	36.81	581
+03	38.91	740	+42	36.73	574
+04	38.90	739	+43	36.67	570
+05	38.84	735	+44	36.62	566
+06	38.80	732	+45	36.47	555
+07	38.78	730	+46	36.40	549
+08	38.74	727	+47	36.36	546
+09	38.68	723	+48	36.26	539
5+10	5438.67	722	+49	36.22	536
+11	38.66	721	5+50	36.15	530 {Pin #12 Missing
+12	38.64	720	+51	36.08	524
+13	38.64	720	+52	35.99	518
+14	38.60	717	+53	35.95	515
+15	38.54	712	+54	35.91	512
+16	38.48	707	+55	35.81	505
+17	38.40	701	+56	35.73	498
+18	38.33	696	+57	35.73	498
+19	38.27	692	+58	35.66	493
5+20	5438.24	689	+59	35.62	490
+21	38.17	684	5+60	5435.60	489
+22	38.10	679	+61	35.48	479
+23	38.00	671	+62	35.41	474
+24	37.99	670	+63	35.30	466
+25	37.98	669	+64	35.29	465
+26	37.92	665	+65	35.24	461
+27	37.88	662	+66	35.21	459
+28	37.82	657	+67	35.12	452
+29	37.76	653			
5+30	37.71	649			
+31	37.57	638			

The pins are located along the south side of the reservoir.

APPENDIX B

INSPECTION CHECKLIST

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
DAM SAFETY INSPECTION REPORT

NAME OF DAM ____________________
DATE INSPECTED ____________________

INVENTORY NO. ____________________
HAZARD CATEGORY ____________________
TYPE OF DAM ____________________
YEAR BUILT ____________________

OWNER ____________________
OPERATOR ____________________
STREAM ____________________
DRAINAGE AREA ____________________

Reservoir Storage Status

	Water Surface Elevation (feet)	Storage (acre-feet)
At time of inspection	________	________
At spillway crest	________	________
At min. dam crest elevation	________	________
Flashboard crest elevation	________	________

ITEM	YES	NO	REMARKS	*ICC

1. EMBANKMENT

A. Crest -- Height= Length= Width=

(1) Any visual settlements?				3
(2) Any misalignments?				4
(3) Any cracking?				1
(4) Any traffic damage?				5
(5) Other?				7

NOTE: *ICC stands for "Inventory Comment Code" which is found on the Inventory of Montana Dams. This comment code is for use by the Dam Safety Section.

ITEM	YES	NO	REMARKS	*ICC

1. EMBANKMENT (continued)

B. Upstream Face -- Slope=

(1) Any erosion?				13
(2) Any longitudinal cracks?				9
(3) Any transverse cracks?				9
(4) Is riprap protection adequate?				10
(5) Any stone deterioration?				10
(6) Any visual settlement, slumps, sloughing, depressions or bulges?				9
(7) Adequate grass cover?				14
(8) Debris on the dam face?				15
(9) Other?				16

C. Downstream Face--Slope=

(1) Any erosion?				22
(2) Any longitudinal cracks?				13
(3) Any transverse cracks?				13
(4) Any visual settlement, sloughing, slumps, depressions or bulges?				19
(5) Is the toe drain dry?				31
(6) Are the relief wells flowing?				31
(7) Any boils at the toe?				13
(8) Any seepage areas?				17, 18
(9) Any traffic or animal damage?				22
(10) Any burrowing animals?				21
(11) Adequate grass cover?				24
(12) Other?				25

D. Amount and Type of Vegetation on the Dam

	14, 24

ITEM	YES	NO	REMARKS	*ICC

2. **ABUTMENT CONTACTS**

(A) Any erosion?				12, 20
(B) Any visual differential movement?				12, 20
(C) Any cracks?				12, 20
(D) Any seepage present?				36
(E) Other?				16, 25

3. **OUTLET WORKS**

A. Intake Structure -- Size=

(1) Any settlement?				70
(2) Any tilting?				70
(3) Do concrete surfaces show:				
a. Spalling?				70
b. Cracking?				70
c. Erosion?				70
d. Exposed reinforcement?				70
(4) Do joints show:				
a. Displacement or offset?				70
b. Loss of joint material?				70
c. Leakage?				70
(5) Metal appurtenances:				
a. Any corrosion present?				70
b. Any breakage present?				71
(6) Trash rack?				71
a. Condition?				71
b. Anchor system secure?				71
(7) Other?				71

ITEM	YES	NO	REMARKS	*ICC

3. OUTLET WORKS (continued)

B. Conduit -- Type = Size =

(1) Do concrete surfaces show:				
a. Spalling?				76
b. Cracking?				76
c. Erosion?				76
d. Exposed reinforcement?				76
(2) Do joints show:				
a. Displacement or offset?				75
b. Loss of joint material?				76
c. Leakage?				76
(3) Is the conduit metal?				76
a. Any corrosion present?				75
b. Protective coatings adequate?				76
(4) Is the conduit misaligned?				76
(5) Any calcium deposits?				76
(6) Other?				76

C. Gates and Tower

(1) Gates:				73, 74
a. Size: Operating: Emergency: b. Type: Operating: Emergency:				
(2) Controls operational?				75
(3) Controls lubricated?				75
(4) Operational problems?				75
(5) Leakage around gates?				73, 74
(6) Condition of gate seals?				73, 74
(7) Any cavitation damage? If so, describe?				73, 74
(8) Describe air vent-size and condition.				73, 74

ITEM	YES	NO	REMARKS	*ICC

3. OUTLET WORKS

C. Gates and Tower (continued)

(9) Is there a jet pump?				62
a. Is it operational?				62
b. Leakage?				62
(10) Is the tower dry? ____ wet? ____				77
(11) Any seepage in the tower?				77
(12) Condition of the tower?				77
(13) Any safety problems?				77
(14) Ladder in good condition?				77
(15) Condition of the gate house?				81
(16) Emergency plan completed for the dam?				43
a. Posted in the gatehouse?				43
(17) Other?				82

D. Stilling Basin

(1) Do concrete surfaces show:				
a. Spalling?				62
b. Cracking?				62
c. Erosion?				62
d. Exposed reinforcement?				62
(2) Do joints show:				
a. Displacement or offset?				62
b. Loss of joint material?				62
c. Leakage?				62
(3) Do energy dissipators show:				
a. Signs of deterioration?				62
b. Are they covered with debris?				62
(4) Other?				63

ITEM	YES	NO	REMARKS	*ICC

3. OUTLET WORKS (continued)

E. Downstream Channel

(1) Is the channel:				
a. Eroding or backcutting?				38
b. Sloughing?				38
c. Obstructed?				40
(2) Is released water:				
a. Undercutting the outlet?				52, 62
b. Eroding the embankment?				52, 62
(3) Other?				56,63

4. **SPILLWAY**

A. Description

(1) Location?				N/A
(2) Type of Spillway?				N/A
(3) Size of Spillway?				N/A
(4) Spillway lining?				N/A
(5) Is there a weir?				61
(6) Is the spillway in good condition?				N/A
(7) Any drains?				N/A
a. Describe the condition of drains.				64

B. Does spillway show:

(1) Any cracking concrete?				57, 58
(2) Any spalling concrete?				57, 58
(3) Any exposed reinforcement in the concrete?				57, 58
(4) Any erosion?				52

ITEM	YES	NO	REMARKS	*ICC

4. B. Does spillway show: (continued)

(5) Any slope sloughing?				51
(6) Any obstructions?				54
(7) Displacement or offset joints?				59
(8) Loss of joint material?				57, 58
(9) Leakage at the joints?				57, 58
(10) Other?				63

C. Do the energy dissipators show:

(1) Signs of deterioration?				62
(2) Any cracking?				62
(3) Any spalling?				62
(4) Any exposed reinforcement?				62
(5) Are they covered with debris?				62
(6) Other?				64

D. Has release water:

(1) Eroded the embankment?				52
(2) Undercut the outlet?				52
(3) Eroded the downstream channel?				52
(4) Other?				56

E. Emergency Spillway

(1) Is there an emergency spillway?			(If YES, describe)	55

ITEM	YES	NO	REMARKS	*ICC

5. **RESERVOIR CONTROL**

(A) Recent upstream development?				47
(B) Recent downstream development?				47
(C) Slides in reservoir area?				44
(D) Change in reservoir operation?				48
(E) Large impoundment upstream?				49
(F) Any debris in the reservoir?				50
(G) Other?				50

6. **INSTRUMENTATION**

(A) List type(s) of instrumentation:				27-33
(B) In good condition?				27-33
(C) Read periodically?				27-33
(D) Is data available?				27-33
(E) Include all data gathered since last report.				

7. **DOWNSTREAM CONDITION**

A. Downstream Land Use.

	41

This dam was inspected by:

Additional comments and recommendations. (Use additional pages)